

The design of a support chair for more effective patient rehabilitation

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Abstract. The authors examined the effect of different color shades on a person and found an effective color and shape solution that can improve the quality of rehabilitation equipment. The paper presents a survey of colors and shapes visual perception by human. As result of theoretical and experimental research, the rehabilitation support chair was designed as a cube-shaped structure with elements painted in shades of dark blue, yellow and white.

1. Introduction

Our contemporary lifestyle is diverse and dynamic. Being outdoors, at work or at home, people consciously or unconsciously contemplate the objects around them. Each of these objects has such parameters as shape and color. What do shape and color of surroundings matter in our lives and how do they influence us? People have become interested in these questions for a long time, and they still remain topical, especially if they concern their professional activities. This paper discusses the choice of a shape and color scheme in the design of a support chair. The support chair is a type of sitting equipment used in rehabilitation of children with cerebral palsy and various congenital disorders. Staying in the support chair is a postural therapy. In order to make this procedure easily tolerable, the equipment is completed with a table which allows a child to draw, write and eat during the rehabilitation.

The main function of the support chair is postural rehabilitation. Its auxiliary functions include assistance in eating and educational activities such as reading, writing, drawing, and various board games. Taking into account these functions, we can argue that the visual appearance of the equipment should create senses of harmony, stability and concentration in order for the rehabilitation to be most effective. This problem can be solved by choosing a shape and color scheme of the product [1].

2. Shape selection

Speaking about the product shape, we should consider static and dynamic properties. Based on the previously defined functions of the support chair, we can say that it should be as static as possible. A square is known to be the most static geometric figure. The volume enhances this property. Therefore, if we take a cube as the basis for designing the product shape, it will be as static as possible from the perspective of visual perception [2]. The concept of statics can also be attributed to one of the basic properties of the subject under study, since its main function is associated with stability, concentration and harmony [3].

To confirm the theory of the greatest degree of static square compared to other figures such as a circle, triangle and rectangle, an experiment was conducted in the form of a survey using Google Forms. In the presented survey, respondents had to distribute points from 1 to 4 and determine how



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much the selected geometric figures evoke the sensations of harmony, stability, concentration. These sensations are most important for visual perception of the designed product. 84 people participated in the survey. As shown in Table 1, the shape of the square evokes feelings of harmony, stability and concentration of attention more than other figures; the final average value was 10 points.

Table 1. Influence of Shapes on Human Perceptions.

	Square	Circle	Triangle	Rectangular
Harmony	4	4	2	3
Stability	3	1	3	1
Concentration	3	2	1	1
Total	10	7	6	6

Summing up the choice of the shape for the support chair using the analysis of the theoretical data and the experiment, we can argue that a square (or a cube in volume) is the best choice in the design of this equipment that produced senses of stability, harmony and concentration. It should be noted that the circle is ranked the second (7 points on average) and can also be used in the product design. Three-dimensional figures based on a circle, such as a ball or a cylinder, can be used as shapes for minor details of the product design.

2. Choice of color solutions

Now let us consider how different shades of color affect people and how the quality of rehabilitation equipment can be improved using an effective color scheme. To solve these problems, we analyzed some knowledge of colors from the perspective of human visual perception.

Johann Wolfgang Goethe, a German writer, thinker, philosopher and naturalist, was one of the first to become interested in this subject. In his *Theory of Colours*, Goethe argues (cited from [4]): “Since color occupies so important a place in the series of elementary phenomena, filling as it does the limited circle assigned to it with fullest variety... we shall not be surprised to find that it produces an effect on the eye, with which it is immediately associated and by means of which it acts on the mind... producing this impression in their most general elementary character, without relation to the nature or form of the object on whose surface it is apparent”. Let us consider how Goethe and other authors describe different colors.

2.1. Yellow

In his *Theory of Colours*, Goethe describes it as follows: “Bright, joyful. Noble and magnificent like gold. Gives an impression of warmth to everything it touches [4]. Max Lusher, a Swiss psychologist, known for inventing a color test [5], describes yellow as the brightest color in the test, perceived as a source of light and cheerfulness. Yellow symbolizes relief from burdens, pressure and problems. In his book *Color Harmony*, Hideaki Chijiwa, a professor of Musashino Art University [6], describes yellow as follows: “Yellow is the radiance of the sun. This lively, cheerful, joyful color is overpowering, and you can get tired of it.”

2.2. Orange

Orange or red-yellow. Goethe describes it as follows: “It has the properties of red color, but is not aggressive. It has a very soft and exciting effect, causes a feeling of warmth and joy, promotes a good mood. Orange represents motion, cheerfulness, sociability, achievement, and self-affirmation” [4]. According to Max Lusher, yellow-red is the most stimulating of all colors [5]. If you look at this color for a long time, it will increase your heart rate, blood pressure and breathing. Hideaki Chijiwa “identifies orange as a warm, bright, vibrant and aggressive color, like hot lava erupting from the

crater of a volcano” [6]. In his opinion, these hues attract our eyes and evoke emotions to a greater extent than other colors.

2.3. Red

According to Goethe’s expression, red is opacity of light [4]. This color can be understood as the most materialized light, reaching its critical point before being lost in darkness. Red is life, energy, passion, will to win, activity, fire, heat, power, impulse, anger, fire, and blood. Lusher writes that the psychological meaning of this color is excitement, activity, and stimulation [5]. A joyful response to red indicates an expression of great strength, stimulation, and self-confidence. Red represents the “appetite”, physical activities like sports and sex, emotional excitement, passion, and ardor. Feeling antipathy towards red color, a person perceives it as a source of threat, anguish, disgust, and anger. In his book *Color Harmony*, Hideaki Chijiwa notes that red is full of passion, that it is the color of heart and fire [6].

2.4. Violet

Johann Wolfgang Goethe calls this color “blue-red” and mentions the Catholic higher dignitaries who have appropriated this unquiet color to themselves; anxiety is growing and striving for cardinal purple [4]. Violet is full of dignity; it is calm, and restrained. People see something serious, mystical, mysterious, and heavy in this color. It can even lead to depression. There is an opinion that the name of the color comes from the Spanish word “violar: which means “to dirty”, “to stain”, “to spoil”. It can be assumed that the viola, a low-register string instrument, producing a solemn, mystical sound, was named so because it was associated with the darkness that would come beyond the violet. Max Lusher called violet the color of transcendence, the transition to a world dominated by emotional values, as well as a representation of impressionability, enthusiasm, curiosity, and identification [5]. Hideaki Chijiwa associates this color with a regal appearance and calls it somewhat “artificial” since it is quite rare in nature [6].

2.5. Light blue

Goethe says: “As yellow is always accompanied with light, so it may be said that blue still brings a principle of darkness with it. “As a hue it is powerful, but it is on the negative side, and in its highest purity is, as it were, a stimulating negation. Its appearance, then, is a kind of contradiction between excitement and repose” [4]. Light blue represents the sky, ice, cold, isolation, tact, and sincerity. This color relieves stress, calms, promotes the development of imagination, liberates, and leads away from reality. Hideaki Chijiwa describes light blue as youthful and athletic [6].

2.6. Dark blue

Johann Wolfgang Goethe says that “blue gives us an impression of cold, and thus, again, reminds us of shade” [4]. Blue represents wisdom, depth, calmness, vision, silence, idealism, constancy, devotion, seriousness, dedication, and severity. One of the most famous poems by I. V. Goethe fully captures the essence of dark blue:

“Over the tops of the mountains in peace;
In the trees scarce a breath stirs their crest;
And the birds in the wood singing cease;
Only wait – soon though too shalt have rest.”

It attracts and fascinates, invites us to meditation, to searches for life’s purpose and truth, but it can lead to melancholy and weakness of spirit. Max Lusher writes that blue evokes a sense of the deepest peace, relaxation, satisfaction, harmony, orderliness, unity, and security. It is no coincidence that the veil of the Virgin Mary is traditionally painted in blue. Hideaki Chijiwa described blue as a color creating an atmosphere of well-being [6].

2.7. Green

Goethe calls green the color of satisfaction, tranquility and balance [4]. Green is nature and harmony. It soothes and pacifies, promotes concentration, calmness and serenity, helps to concentrate and make a decision. Moreover, green contains potential energy, contributes to prosperity and stability. The Russian word “green” (*zeleny*) comes from the Old Russian word “*zelo*” which means “highly”, “greatly”, “very”, “strongly”. Lusher characterizes green as creating stability and constancy, emphasizing a sense of self-worth, expressing as respect, dignity, authority, and competence [5]. Hideaki Chijiwa says that green reminds us of spring and fertility, but it is also the color of mold, poison and jealousy [6].

2.8. Brown

This color is formed by mixing red with black, which makes it more “earthy”, expressing constancy and reality. Calm, strong earthy hues of brown give an impression of something massive, confident and compact [4]. Lusher writes that brownish red has a connotation of peace [5]. Hideaki Chijiwa says that brown is rich, “soil-like”, but also sad like autumn leaves [6].

2.9. White

Being a substitute for light, white makes our eye work [4]. Lusher writes that white is the lightest of all colors [5]. It can be perceived as dazzling. White is the color of purity and innocence. In Christian traditions, it is the color of holiness. Hideaki Chijiwa describes white as purity, virginity and peacefulness. On the other hand, it represents winter and hospital sterility [6]. Attributes of Colors are presented in table 2.

Summing up the information on human visual perception of color, we can argue that such colors as dark blue, light blue, green and white contribute to concentration and produce a sense of stability and harmony [7]. Yellow, orange and red evoke such emotions as cheerfulness, joy, and vigor, help to improve mood, and increase the motivation for rehabilitation sessions [8]. This condition is necessary for effective rehabilitation, since people with serious illnesses are often depressed and lose the desire to systematically conduct exercise sessions using rehabilitation equipment.

The authors carried out a survey on human perception of color shades, which can evoke a feeling of harmony, stability and concentration. In the survey, respondents had to distribute points from 1 to 9 and determine how different shades evoke the sensations mentioned above. Based on the main function of the support chair - fixing the patient in the sitting position, a color solution creating a feeling of concentration, harmony and stability was determined. The survey involved 82 people of different sex and age. As shown in Table 3, dark blue, with an average score of 24 points, produces senses of harmony, stability and concentration to the greatest extent.

Table 2. Attributes of Colors.

	Goethe	Max Lusher	Hideaki Chijiwa
Yellow	Clear, joyful, noble	Bright, cheerful, liberating	Sunny, lively, cheerful, joyful
Orange	Joyful, warm, conducive to good mood	Energizing	Warm, bright, colorful, aggressive
Red	Serious, full of dignity, charming, passionate, pretty	Exciting, energizing, stimulating, strengthening, empowering, appetizing, sexy, passionate, angry, tormenting	Passionate, hearty, fiery
Violet	Disturbing, insufferable in its dark shades	Impressive, enthusiastic, curious	Regal, unrealistic

Light blue	Combining excitement and peace, running away from a perceiver, cold, shady	-	Youthful, athletic
Dark blue	Carrying you to a place where you can rest. Lively but joyless	Calm, relaxing, satisfying, harmonious, protective	Creating an atmosphere of well-being
Green	Satisfying, soothing, balancing	Stable, consistent, meaningful, authoritative, competent	Spring, fertile, poisonous, jealous
Brown	Unpleasant, shameful, disgusting.	Pacifying	Rich, earthy, sad
White	-	The lightest, dazzling, pure, innocent, holy	Pure, virgin, peaceful, wintry, sterile

Table 3. Influence of Colors on Human Perceptions.

Color	Concentration	Harmony	Stability	Total
Yellow	3	4	4	11
Orange	2	2	3	7
Red	1	1	2	4
Violet	4	3	1	8
Light blue	5	6	5	16
Dark blue	8	7	9	24
Green	6	7	8	21
Brown	8	4	6	18
White	7	8	7	22

3. Conclusion

Autodesk Fusion 360 was used to develop a 3D model of a support chair based on theoretical and experimental studies. The general shape of the support chair is presented in the form of a cube, and the functional elements were made in the form of other forms using basic colors: blue for stability, yellow for cheer, and white for purity. Based on the 3D model of the chair-support, it is planned to register an industrial model and get a patent for the invention.

The image of the designed equipment is shown in Figure 1.

**Figure 1.** Image of the rehabilitation support chair.

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